Dionysius Lardner, the denigrated sage of early railways

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Abstract. Dionysius Lardner has a very poor reputation in the railway history literature. In most other fields he also tends to be remembered either for a few of his occasionally spectacular mistakes or at most as a minor science and technology popularizer. He has not received proper credit for his striking 1846 survey of the railway industry, 'Railways at home and abroad.' Published at the peak of the Railway Mania, it provided an excellent overview of that rapidly developing industry. Most important, it punctured several false myths that motivated investors. Had proper heed been paid to Lardner's warnings, much of the investment disaster of the Mania could have been averted. This episode of financial exuberance can be shown to have been doomed to fail, and among contemporary observers Lardner provided the most convincing and comprehensive arguments to demonstrate this. However, little attention was paid to his warnings. This episode provides another illustration of the difficulty in persuading the public as well as policy makers that a dangerous bubble is in progress and bound to fail.

Introduction

The Rev. Dr. Dionysius Lardner (1793 – 1859) has not been treated kindly by railway historians. An extreme example is Rolt's characterization of Lardner as an 'egregious ass [who kept] popping up to provide comic relief to the dullest piece of research'[1]. And it is indisputable that Lardner did make numerous mistakes, although it has to be said that the majority of the popular tales about him are embellished, often greatly so. Most of Lardner's missteps were in the technical sphere, for example in his arguments over the Box Tunnel and over the feasibility of transatlantic steam travel. In addition, there was his great moral transgression, shocking to the early Victorians, namely his notorious 1840 elopement with Mrs. Heaviside. These are all described in the only book-length biography of Lardner to be published so far, *The Villain of Steam* by Anna Martin[2].

Hawke in *Railways and Economic Growth ...* provided a partial rehabilitation of Lardner in the railway literature by summarizing his contributions to other fields where he is viewed much more positively[3]. Those fields included railway accounting, microeconomics, and the theory of the firm. All of them acknowledged the novel contributions of Lardner's 1850

[1] Rolt, L. T. C. (1960) *George and Robert Stephenson: The Railway Revolution,* Longmans, p. 186.
[2] Martin, A. (2015) *The Villain of Steam*, A. de Paor, ed., Tyndall Scientific.
[3] Hawke, G. R. (1970) *Railways and Economic Growth in England and Wales, 1840–1870*, Oxford Univ. Press. See also A. Martin, *op. cit.* (note 2).

book *Railway Economy.* What is still missing from modern literature is recognition of Lardner's striking insights into railway economics in his survey 'Railways at home and abroad,' published in the October 1846 issue of the *Edinburgh Review.* It can be regarded as the seed from which *Railway Economy* sprouted. However, it also had special value for its time. It appeared at the height of the Railway Mania and contained convincing arguments demonstrating this manic period was bound to end in a financial debacle.

The modern mainstream view in economics is that financial bubbles cannot be detected, and adherents of this theory have reached very influential positions[4]. The Railway Mania provides just one of several counterexamples to this dogma. There were solid quantitative reasons as to why this episode of investor exuberance was bound to implode. Lardner, in his 1846 survey, provided the best contemporary collection of data and arguments to show this. He punctured several false myths that motivated investors, such as those about construction costs, locality of traffic, importance of freight traffic, and nature of economic growth. Had proper heed been paid to Lardner's warnings, much of the investment disaster of the Mania could have been averted.

There are other ways to look at this episode, too. Had investors accepted Lardner's hints and cut back the flow of funds into railway construction, the mortality from the Irish Famine would likely have been far greater, as the money contributions from Irish laborers on railway projects to their families would have been smaller. It is also possible that Britain might have been afflicted by the armed insurrections that affected much of continental Europe in 1848. In the runup to those uprisings, most of Europe was suffering serious economic downturns, while Britain basked in the prosperity stimulated by the flood of money into railways. Those speculative thoughts, though, do not detract from the fact that Lardner articulated the fatal mistakes of the Railway Mania better than any one in that period.

British railway manias of the first half of the 19th century

The famous Railway Mania of the mid- and late-1840s was by many measures the greatest technology mania in history. Actual capital investment by private individuals came to about £150 million, which, relative to GPD, is comparable to about £600 billion for the UK of 2018[5]. It was universally regarded as a disaster for investors. Charlotte Brontë wrote to a friend in late 1849 that '[m]any—very many are—by the late strange Railway System deprived almost of their daily bread,' and as late as 1857, the *Economist* lamented that '[i]t is a very sad thing unquestionably that railways, which mechanically have succeeded beyond anticipation and are quite wonderful for their general utility and convenience,

[4] For example, Bernanke, B. S. and Gertler, M. (1999) 'Monetary policy and asset price volatility,' *Federal Reserve Bank of Kansas City Economic Review,* Fourth Quarter 1999, pp. 17–52, available at ⟨http://www.kc.frb.org/publicat/sympos/1999/4q99bern.pdf⟩, has the claim that 'it is difficult or impossible to identify any particular episode conclusively as a bubble, even after the fact.'

[5] Extensive statistics and references are available in the preliminary manuscript Odlyzko, A. (2010a), 'Collective hallucinations and inefficient markets: The British Railway Mania of the 1840s,' available at ⟨http://ssrn.com/abstract=1537338⟩.

should have failed commercially'[6]. It could have been even worse for investors. Parliament authorized around 10,000 miles of new railways during the Railway Mania, but only about 5,000 were built. Had the other 5,000 also been constructed, investment losses would have been far greater.

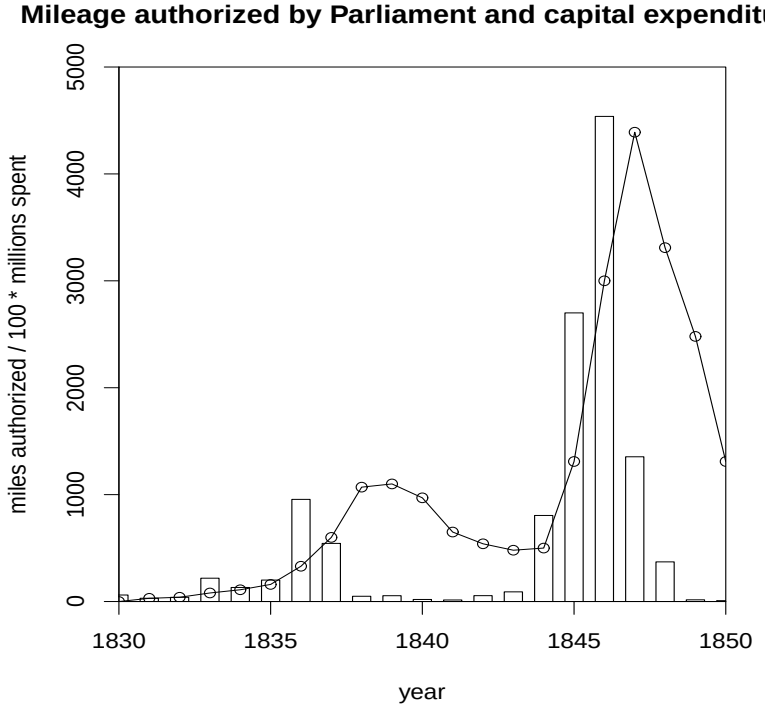

Fig. 1. Railway expansion in the United Kingdom from 1830 to 1850. Bar chart shows the railway mileage authorized by Parliament each year, not all of which was built. Points connected by the line show capital expenditure each year, in units of £10,000, so the peak expenditure in 1847 was £43.9 million, comparable, as fraction of the economy, to about £200 billion for the UK in 2018.

To properly understand the Railway Mania, it is essential to learn about the little-known railway mania of the 1830s. It is visible in Fig. 1 as the blip in Parliamentary authorizations that is most pronounced in 1836 and 1837, and then by an extended period of capital investment that produced about 2,000 miles of working railways by 1844. The constuction costs of that period came to about £70 million, comparable to about £300 billion for the UK today, and thus about half the resources that went into the great Railway Mania. Together with yet another railway mania of the mid-1860s, the mania of the 1830s ranks just behind the Railway Mania among technology manias in terms of capital expenditure relative to the size of the economy. It is unique, though, in being the only known large

[6] Smith, M. ed. (2000) *The Letters of Charlotte Brontë, with a Selection of Letters by Family and Friends: Vol. II, 1848–1851,* Oxford Univ. Press, letter of 4 October 1849; *Economist*, 6 June 1857, pp. 615–616.

investment mania that was successful[7]. There was a crash in share prices, but investors continued pouring in money, even in the face of cost overruns and discouraging market signals. Those who did not sell out, and persisted until the early 1840s, were rewarded with above-market returns.

The railway mania of the 1830s was extremely speculative. At its start, there were just a few hundred miles of working railways in Britain. The only clear examples of successful lines that could be cited by railway enthusiasts were the Stockton and Darlington Railway and the Liverpool and Manchester Railway, each of about 30 miles. There were many skeptics, including most of the financial community, as well as two of the most prominent political economists of the day, John Ramsay McCulloch and John Stuart Mill. Their skepticism was very reasonable. It just happened to be wrong.

As usual, there were large cost overruns on the projects from the 1830s, on average almost by a factor of two. However, revenue projections were surprisingly accurate. Further, profit expectations were extremely generous, often around 12% per year (at a time when the risk-free rate of return was about 3.3%, and a passive equity investment that paid 5% was regarded as excellent). Hence even with the cost overruns, dividends were very good by the time the Railway Mania started in 1844–45.

The accuracy of revenue projections in the 1830s was unprecedented. Extensive studies have shown that there is a standard pattern on large public transportation projects. Promoters, whether they are aiming for private profit, or are government employees, generally underestimate the costs and overestimate the revenues[8]. This pattern recurs consistently, even though construction techniques that are used today are for the most part very well known, with extensive prior experience. Yet in the 1830s, dealing with what was then a revolutionary new technology, the professionals tasked with estimating future demand for railway transport, called the 'traffic takers,' succeeded in obtaining extremely high accuracy. Their work is discussed in the next two sections. It turns out their success was the result of cancellation of mistakes.

The traffic taker methodology was a systematic one that was required by Parliament. It was applied in the 1830s, but at that time it was new and untested. Hence projects from that period were extraordinarily risky, with both cost and revenue estimates hard to rely on. Yet those projects succeeded financially as well as technologically.

By contrast, the Railway Mania of the 1840s was on the surface a very conservative venture. The traffic taker methodology was still being applied. However, by that point it had been validated by the experience of the lines of the 1830s (although this was not noted in public sources to any substantial degree). The engineers were claiming they had learned their lessons and were now able to estimate costs better. They could even point to a few lines built in the early 1840s, such as the Yarmouth and Norwich Railway, which will be

[7] Odlyzko, A. (2010b) 'This time is different: An example of a giant, wildly speculative, and successful investment mania,' *B.E. Journal of Economic Analysis & Policy,* vol. 10, issue 1, 2010, article 60. Preprint available at ⟨http://ssrn.com/abstract=1573974⟩.

[8] Flyvbjerg, B., Bruzelius, N., and Rothengatter, W. (2003) *Megaprojects and Risk: An Anatomy of Ambition,* Cambridge Univ. Press.

mentioned later, which was completed at a much lower costs than the lines of the 1830s. Their arguments were helped by several factors. There had been general improvements in technology. For example, locomotives could handle steeper inclines, while the electric telegraph improved signaling, leading to more efficient utilization of lines. In addition, there was the rise of large contractor firms, such as those of Brassey and Peto. They could undertake large projects, often on a fixed-price basis, and allow railway managers to avoid the problems of coordinating the work of many often underqualified contractors that bedeviled railways of the 1830s.

Even though the Railway Mania of the 1840s appeared to be based on much more solid foundations than the mania of the 1830s, it failed disastrously, at least from the standpoint of investors. (It is easy to argue that social savings to the country more than counterbalanced those losses, even aside from the likely effects in ameliorating the Irish Famine and preventing an armed revolt in 1848.) Costs were again higher than promised. But this time revenue projections were also erroneous, as they turned out to be too high. An important factor in the investment failure was the small margin of safety. The business cases presented to Parliament, based on the estimates of engineers and traffic takers, only promised profits of about 6.5% on invested capital. This information was widely known. The public could see it in the prospectuses published by new rail projects. They also had access to some comprehensive statistics that demonstrated this[9]. Thus the widely held expectations of 10% profits could have been realized only if the revenue estimates were far too conservative, and if cost estimates had been valid. Instead, there was failure in both cost and revenue projections. The former were underestimated, and the latter overestimated. To a large extent, the public apparently never fully realized the reasons for the poor financial performance, as they tended to blame corruption for the debacle[10].

There was much negative material in the press about railways during the Railway Mania. However, one has to be careful in evaluating such coverage, going into it in more detail than has been done in the past[11]. Much of the negative coverage reflected projects denigrating competing ones. Still, there were many prominent and vocal opponents of the Railway Mania as a whole. *The Times,* which at that time had an unprecedented influence on public opinion, was in the vanguard of those fighting the Mania. The *Economist* was also prominent on that side. However, both those press organs were concerned primarily about the scale of railway investments, and the danger they posed to the economy[12]. Neither denied that railways were useful and would be profitable to their shareholders. Hence they

[9] A table showing estimated capital, revenues, and profits for all the lines sanctioned in 1845 was published in the *Railway Chronicle*, 16 August 1845, p. 1015, reprinted on the same day in the *Morning Post*, p. 3, and later in other papers, including the *Scottish Railway Gazette*, 6 September, p. 380.

[10] Odlyzko, A. (2012) 'The Railway Mania: Fraud, disappointed expectations, and the modern economy,' *J. Railway & Canal Historical Society,* no. 215, November 2012, pp. 2–12. Preprint available at ⟨http://www.dtc.umn.edu/∼odlyzko/doc/mania06.pdf⟩.

[11] Cf. Campbell, G., Turner, J. D., and Walker, C. B. (2012) 'The role of the media in a bubble,' *Explorations in Economic History*, vol. 49, no. 4, 2012, pp. 461–481.

[12] *The Times* had been skeptical for some time, and really went on the warpath with its 1 July 1845 leader, ''Whence is to come all the money for the construction of the projected railways?' is a question which at the present day we often hear familiarly repeated.'

did not provide any warnings to individual shareholders that they were entering ruinous ventures.

An even more striking case is that of James Morrison. Generally regarded as the richest commoner of the 19th century, he was an MP, and a pioneer in public utility regulation. His concern was that the government's policy of giving charters without the ability to control future prices would allow railways to reap windfall profits from economic growth, and this would throttle the rest of the economy. Lardner's survey appeared just as *The Times* was in the middle of publishing a series of two dozen letters arranged by and inspired by Morrison. They appeared under the pseudonym 'Cato,' and argued for Morrison's proposed solutions[13]. Much of the discussion in them concerned the excessive profits that railway shareholders were likely to obtain. Hardly a message to discourage investors!

There were very few warnings that the basic foundations of the Mania were illusory, and that prevailing hopes of high profits were bound to be disappointed. Lardner's 'Railways at home and abroad' was the most comprehensive work in that direction.

Lardner and his mistakes

Lardner was famous in his lifetime as a science and technology popularizer. He introduced Ada Lovelace and most of the world to Babbage's pioneering work on computers, was the person who first called George Stephenson 'the Father of Railways,' and coined the word 'derailment.' He wrote numerous popular books, with *Steam Engine* going through 8 editions in England, and several in America. He was also an acclaimed lecturer. Two decades after his death, an observer who had heard him in person wrote that

> [Lardner] had the rare talent to lecture on the most abstruse science and make his audience understand every word he uttered. ... Faraday, as a lecturer, was most probably the only man ... that could approach Lardner in making light out of darkness, knowledge out of ignorance, and so magnetizing an audience as to hold them 'spellbound' until he chose to break the charm by shutting down on his own voice.[14]

During the early and mid-1830s, Lardner was at the height of his stature as an expert, testifying before Parliamentary committees, and being cited as an authority on technical topics. This phase of his life ended with his elopement with a married woman in early 1840. Having affairs was not uncommon in those days, and Lardner himself had earlier been involved in some complicated intimate relations in Dublin that would likely have scandalized his audiences, were they widely known. The 1840 elopement, though, was in a different category, as it was a very public affair, in which his paramour (and future wife, after her divorce in 1845) left her children behind. That ended Lardner's career in Britain, and he spent several years in America, engaging in several long and very successful popular lecture tours.

Lardner's technical stature was already on the wane when he was forced to leave Britain in 1840 as a result of the elopement. He was increasingly regarded as an intellectual

[13] Gatty, R. (1977) *Portrait of a Merchant Prince: James Morrison, 1789–1857,* Pepper Arden.
[14] Letter in the *New York Times,* 17 January 1881, p. 2.

lightweight, and this perception was reinforced by some very visible mistakes. The most notorious was his skepticism about the feasibility of transatlantic steam travel. He was not the only skeptic on this subject, but he was the most outspoken. He lectured on this topic at numerous meetings, and in December 1835 he declared that 'the project ... of making [a steam] voyage directly from New York to Liverpool ... was ... perfectly chimerical, and they might as well talk of making a voyage from New York or Liverpool to the moon'[15]. The successful voyages of the *Sirius* and the *Great Western* in April 1838 seriously dented Lardner's reputation.

Why did Lardner go so badly astray? There were several elements in his reasoning that turned out to be incorrect. He appeared not to understand the difference between ship measurement tons and regular tons of weight (essentially ship displacement), and he did not allow for the fact that larger ships needed less power relative to their size than smaller ones[16]. But his greatest mistake appeared to lie in not allowing for technological progress. He carefully collected the best data he could find on performance of existing steam ships, and extrapolated from that to the planned transatlantic vessels. Opponents, led by Isambard Kingdom Brunel, the designer of one of those ships, argued that he was too conservative in his estimates, that the latest engines being built at the time would do better, but Lardner refused to admit that.

After the failure of his prediction, Lardner devoted inordinate energy throughout the rest of his life to explaining away his error. We should remember that he was not the only one making mistakes. Even in the 1840s people would occasionally recall some of the predictions by the most famous and accomplished engineers of that era that had been made just a decade or two earlier, and by that time were perceived as ludicrous[17]. (This was aside from the notorious cost underestimates and time to completion and performance overestimates. Technologists were already widely known for those then, and continue to be known for today.) There were many observers who were either amused or annoyed by Lardner's continuing efforts to explain away his transatlantic steam mistake, and counseled him to simply admit he had been wrong, and move on. He stubbornly refused to do so. In particular, he claimed that he had not denied the possibility of crossing the Atlantic under steam in principle. Instead, he claimed he had only denied the commercial prospects of such trips[18].

It is worthwhile reviewing a couple of Lardner's other mistakes, as they show a pattern of thinking and operating that we see in much of his work. One of them concerned another famous dispute with Isambard Kingdom Brunel about the technical choices on the Great Western Railway (GWR) in late 1838. At that time the GWR was under construction, and

[15] *Macclesfield Courier,* 5 December 1835.

[16] It took some decades before Froude proved by careful water tank experiments the two-thirds power law, but the general principle was known well among naval experts.

[17] A nice example is the series of articles entitled 'Railway retrospective review' in the March, April, June, and July 1847 issues of the *Monthly Railway Record.*

[18] It should be mentioned that some observers accepted this claim, and acclaimed his foresight. Aside from Cunard's line, which benefited from the lucrative monopoly contract for mail transport, all other early steamship lines failed.

a large group of shareholders (dominated by the 'Liverpool interest') was getting concerned, largely about Brunel's design choices[19]. They forced GWR management to commission two studies, one by John Hawkshaw, the other by Nicholas Wood. Wood, in turn, subcontracted part of his task to Lardner, who spent some weeks collecting measurements and analyzing the data. The whole affair culminated in several reports and a stormy meeting of GWR shareholders that was unusual for the detailed level of technical discussion[20]. Charles Babbage, the famous pioneer of digital computing, was among the speakers[21]. Lardner came out with an adverse evaluation of Brunel's claims, based on the measurements that had been collected and his own theoretical explanations for them. Brunel and Daniel Gooch, the GWR locomotive engineer, had their jobs on the line, and so searched for mechanical problems that might have produced the poor performance observed by Lardner. They quickly discovered they could obtain a big improvement by the simple expedient of enlarging the blast pipe of their locomotive. That detracted from the credibility of Lardner's entire report. That credibility was already in question, of course, due to the spectacular demolition of his transatlantic steam prediction less than a year earlier. During the shareholder meeting, when Babbage mentioned a table that had been prepared that covered train speeds up to 80 miles per hour, the chairman 'remarked, that Dr. Lardner would assure them that the laws of gravity would become suspended long before that,' a remark that produced wide laughter. That and other negative comments about Lardner during the meeting likely contributed to the decision by the shareholders. They had good grounds for voting against the management's course. The Hawkshaw report, in particular, was scathing in its critique of Brunel's decisions, and, in retrospect, was correct on almost every point. However, in the end, shareholders voted to endorse Brunel and the GWR directors, by a margin of 7,792 to 6,145. Had Lardner been more competent, or simply had not been involved at all, it is quite possible the vote might have gone the other way. That probably would have ended Brunel's career. Britain and the world might have been deprived of his technical innovations, but his investors would have saved a lot of money and grief.

The 1838 GWR episode shows nicely Lardner's strengths and weaknesses. He was ahead of most of his contemporaries in understanding the importance and value of systematic data collection, and of building models based on real data[22]. On the other hand, he often jumped to conclusions, and was neither a deep thinker nor a practical engineer. He was also reluctant to acknowledge his mistakes. Those characteristics played a key role in another

[19] Brunel already had a reputation for expensive and fancy construction, in contrast to Joseph Locke, who was renowned for low costs. Cf. Vaughan, A. (1991) *Isambard Kingdom Brunel: Engineering Knight-Errant,* John Murray; Chrimes, M. (to appear) 'The safest pair of hands: Joseph Locke, 1824–1839,' in proceedings of the Second International Early Main Line Railways Conference, M. Chrimes, ed.

[20] The most detailed coverage of the meetings, as well as the reports, are in the *Railway Times,* in the issues of 5, 8, and 12 January 1839 (with the second of the three a special, long issue). The entire affair attracted intense interest from all who were involved with railways.

[21] Babbage was a friend of both Brunel and Lardner, and a substantial investor in the GWR. He took Brunel's side at the meeting.

[22] Cf. Lewis, I. (to appear) 'Science in the early main line railway period,' in proceedings of the Second International Early Main Line Railways Conference, M. Chrimes, ed.

major misstep by Lardner, one that is not mentioned in the modern literature. It concerns his pioneering studies on the demand for railway transport.

Practically all railway projects in Britain required government sanction. To obtain it, promoters almost always had to undergo systematic scrutiny by Parliamentary committees, where opponents had an opportunity to question new projects' plans. This required the promoters to demonstrate that the project would be feasible and would provide public benefits. The general philosphy was that a new line had to have decent prospects of good profits, as that was seen as the only way to guarantee it would be built and operated. Engineers testified as to costs. Estimates of prospective revenues came from a group of experts called the 'traffic takers.' These were a small group of people who developed expertise and reputation in the 1830s in the preparation of the 'traffic tables,' the essential elements in new projects' estimates of revenues[23]. The basic methodology was one that evolved from the hearings on the London and Birmingham Railway proposal[24]. A key element in this methodology was an extrapolation from passengers seen traveling by coaches and other conveyances on roads to the the number that would travel by rail. The traffic takers' skill and art was in deciding which travelers to include in the count. The basic approach was to take that number and double it, to reflect the stimulating effect of faster, less expensive, and more convenient railway travel. Most of the revenues for projects in the 1830s and 1840s were projected to arise from passenger travel, estimated by this method.

How well did this method work? That was not studied systematically at that time, nor since then. What was constantly repeated, by critics as well as supporters of railways, was the mantra that 'demand has far exceeded expectations.' This became such an ingrained part of the 'accepted wisdom' that it survived the debacle of the Railway Mania. As just one example among many, at one of the shareholder meetings of the Great Northern Railway in 1854, its chairman, E. Denison, declared[25]:

> There could be no doubt that the railway had cost a great deal more money to construct it than was estimated; but, at the same time, it must be borne in mind that the traffic on the line far exceeded the estimate proved before Parliament, and all expectations.

[23] Properly speaking, the top professionals in this area, with William Pare the most eminent, preferred to call themselves 'traffic statists,' in the days when statist was used to denote a person we call a statistician. They used the designation 'traffic takers' for the people they employed to collect data on traffic on roads. However, the press and the public tended to use 'traffic takers' for everyone in that line of work.

[24] This methodology was described by Peter Lecount in his entry on railways in the 7th edition of the *Encyclopaedia Britannica,* and also in his book, Lecount, P. (1839) *The History of the Railway Connecting London and Birmingham,* Simpkin, Marshall, and Co. Several detailed reports that relied on this methodology were presented at the London and Southampton Railway meeting, and were reprinted in the *Morning Chronicle,* 31 August 1837, pp. 3–4. Many others were published by other railways. Hence the public had easy access to the principles on which demand estimates were based.

[25] *The Times,* 28 August 1854, p. 8.

How could this view prevail? It turned out there was a plausible argument to be made, with some facts to support it, and Lardner played a role in its creation. It depended on looking at projections of the number of passenger trips, and ignoring revenues.

In late 1835, as the smaller railway mania of the 1830s was nearing its peak, Lardner prepared the 5th edition of his *Steam Engine* book. Revisions to this work, which was primarily about technology, included the addition of a chapter on 'Plain rules for railway speculators.' This addition was warmly welcomed by a public hungry for investment advice. This is shown by numerous reprints of it in newspapers, including *The Times*. The second of these rules was:

> A probable estimate of the number of passengers to be expected upon a projected line of railroad may be made by increasing the average number of passengers for the last three years, by the common road, in a twofold proportion.

This was the basic rule used by the traffic takers, and was the one accepted by Parliamentary committees. Half a year later, in the 6th edition of his book, he made a change (without saying this was a change), in that he replaced 'twofold' by 'threefold,' and provided data to substantiate the assertion[26]. Just a couple of months later, Lardner participated in a meeting of the British Association for the Advancement of Science in Bristol. That is where he made his most famous and notorious speech about the impracticality of steam travel across the Atlantic. However, at this same meeting, he also lectured on the effects of railway travel and concluded from the statistics he had collected 'that the law of increase was fourfold.' There was some discussion at the conclusion of his lecture, with participants expressing doubts about the validity of his conclusions since they were based on limited data[27].

On the other hand, Lardner's 4x estimate was embraced enthusiastically by the railway industry, as it provided an endorsement of an established scientific figure for their optimistic business plans. Thus the *Derby Mercury* of 31 January 1838 wrote that 'Dr. Lardner has proved abundantly that in every case where a railway has been constructed, the transport of passengers has increased in an immense proportion. In no instance has it been less than four to one, even where the fares have been increased by it.' After a while it stopped being attributed to Lardner, and was quoted as a part of the common knowledge shared by everybody. It was cited across the Atlantic, and in semi-official statistical compilations in Britain. In particular, George Richardson Porter is remembered as a careful compiler of quantitative information, the first head of the statistical department of the Board of Trade, and later first supervisor of the railway department there. In his famous *The Progress of the Nation*, he claimed that

> Hitherto it has been found, in nearly every case where a railroad adapted for carrying passengers has been brought into operation, that the amount of travelling between the two extremities of the line has been quadrupled.

[26] It is rather surprising that Lardner used the 2x growth projection in the 5th edition of his book. In an earlier publication, an article in the *Edinburgh Review* of October 1834, he already used the 3x figure.

[27] A brief report with the 4x estimate appeared already in the *Morning Chronicle* of 26 August 1836. Fuller accounts were in the *Bristol Mercury* of 27 August and the *Athenaeum* of 3 September.

This assertion was present in all three editions of that book published in his lifetime, those of 1838, 1847, and 1851.

Railway promoters cited Lardner's conclusion to still doubts about their projects by saying that the business cases presented to Parliament were based on 2x growth, whereas the true figure was 4x. Therefore profits were bound to be much higher than in those sanctioned business plans, even if the engineers turned out to have underestimated the costs.

There was no cheating involved in deriving the 4x estimate. Lardner, as usual, was careful to collect solid data. And he was again in forefront in studying an important question that nobody else was addressing, namely the accuracy of the traffic taker projections. But, again failing to show deep insight, he did not note there was something seriously misleading about his work. Yes, there were twice as many passengers by rail as expected. But on average they only traveled about half the distance that was expected! Porter's reference to 'travelling between the two extremities of the line' reflected the prevailing popular impression that most of the traffic was between the major cities that were usually the endpoints of railways. Speaking very roughly, on railways started in the 1830s, there were about twice as many passengers as projected by the traffic takers, but they traveled half the expected distance. Therefore the total revenues came out to be just about what the traffic takers promised[28].

Table 1. Edinburgh and Glasgow Railway, revenue estimates and actual results. The 1838 figures came from the traffic taker presentation to Parliamentary committees.

All figures in thousands of pounds sterling.

	Oct. 1830 estimate	Dec. 1830 estimate	Nov. 1831 estimate	1836 estimate	1838 estimate	1844–45 actual
passenger revenue	17.6	48.0	45.0	75.5	82.6	82.3
goods revenue	43.2	35.8	55.5	16.8	41.6	35.1

An example of an exceptionally accurate traffic taker revenue estimate (which also involved an incorrect prediction of the number of passengers) is provided by Table 1[29]. The early estimates by promoters varied a lot, and the jump in expected passenger revenues in the December 1830 entry was undoubtedly justified by the large passenger traffic observed on the Liverpool and Manchester Railway, which opened in September of that year. The traffic taker projections, those of 1838, were the ones presented to Parliament. They were almost exact for passenger revenues, more so than typical. They were about 20% too high for freight, which was a common pattern.

The surprising accuracy of traffic taker revenue projections was only in comparisons to revenues from 1844-45. A few years later, actual revenues increased, and indeed 'far exceeded expectations' of the mid-1830s. However, for investors considering putting money

[28] This is a very high-level approximation. The situation varied from line to line. In addition, actual prices were lower than expected, and running costs higher. Some detailed examples are presented in Odlyzko, *op. cit.* (note 5).

[29] Figures taken from Robertson, C. J. A. (1983) *The Origins of the Scottish Railway System, 1722–1844,* John Donald Publishers, pp. 111 and 166.

into Railway Mania projects, the figures for 1844-45 were the most recent ones they had available.

Lardner's 4x claim served to mislead both the public and policy makers about the real economics of railways, and helped inspire the Railway Mania. His other major assertion from the 1836 meeting of the British Association, that the increase in volume of travelling on railways 'depended infinitely more on the saving of time than money' was based on much more tenuous arguments than his 4x estimate. In retrospect it can be said to be very questionable. But that one did not appear to have much effect on investments.

Lardner's 1846 survey

In 1845 Lardner returned to Europe, and settled in Paris. In mid-1846, he became the Paris correspondent for the *Daily News,* the new London paper that was established by several railway financiers. They included Joseph Paxton, the famous gardener and architect who would later design the Crystal Palace, and who was already an influential figure in the railway world because of the fortune he had accumulated by shrewd investments in that industry. Charles Dickens was the first editor of the *Daily News*, but left after a few weeks. That opened the way for Lardner to obtain the Paris post, as Dickens was one of many British figures who disliked Lardner and refused to hire him.

The writing of 'Railways at home and abroad' was proposed by Lardner to Macvey Napier, the editor of the *Edinburgh Review*. Although this survey was the longest article in the October 1846 issue of that quarterly, at 53 pages and about 25,000 words, it had been shortened substantially by Napier, and may have been modified by him[30]. Thus some of the puzzles that this paper presents, and are discussed later, may be due to Napier's involvement more than to Lardner.

'Railways at home and abroad' was written in the typical Lardner style, very clear, smoothly flowing, and packed with information that, with a few exceptions, was very accurate, and not easily accessible to the British public. It started with a nice historical sketch which showed the dramatic improvement in transportation that resulted from introduction of railways. It then sketched the technological progress of this new industry. Jumping to the end, the article concluded with recommendations for government railway policy that were very 'Morrisonian' in tone, calling for more aggressive supervision of the design and operation of British railways. The bulk of the paper, between the initial historical sketches and the policy conclusions, covered a wide variety of topics. There was an extensive survey of foreign railways, with explanations for some of the facts that were puzzling British observers, in particular the much lower costs of construction and operation in other countries. And there was a wealth of material about British railways. Much of it was just informative, as in the statistics of accidents, or the quantification of gains to society as a whole provided by railways. It was bound to be useful to the 'railway interest,' though, in their fights with railway opponents. On several points, though, Lardner's material contradicted

[30] The letters from Lardner to Napier have been preserved among the Napier Papers at the British Library, Add. MS 34,626.

deeply embedded opinions of not just the public, but even of experts. We next review the observations of this type that were most important for the potential profitability of the new lines of the Mania.

Lardner provided statistics on railway revenues, and concluded (p. 492) 'that there is an annually increasing amount of traffic,' and that 'that the rate of increase on the Goods traffic, is even more rapid than the Passenger traffic.' This was a very radical notion for most people in Britain in the 1840s[31]. The almost universal expectation was that once a line opened, there would be a period of a year or at most two of 'development,' when traffic would increase, but afterwards it would stabilize, aside from extraneous events that might lead to growth or decline. This was a reflection of a general expectation of the economy, that it would benefit from occasional and unpredictable dramatic innovations in technology or business models, but would not experience steady growth year after year. There were observers who understood early on that a new steady incremental growth pattern was taking over, but initially they were few such. Furthermore, there was no debate on this issue, instead there were two camps that were talking different languages and had different expectations. Lardner's key mistake in the transatlantic steam controversy was in taking the static view of technology. But already a few years later he was writing that steady incremental progress was obvious[32]. However, he never admitted that his views had changed. In 'Railways at home and abroad' he did not show any sign of recognition that he had to argue to convince his readers that most of them had the wrong expectations.

Lardner's observation about freight traffic growing faster than passenger traffic was accurate and very novel, and had profound implications for the railway industry. As was noted by Lardner, railways were initially developed for heavy freight carriage. However, the big financial success of lines such as the Liverpool and Manchester Railway came from the enthusiastic embrace by the public of speedy transport of people. By Lardner's estimate, about 63% of the revenues were coming from passengers around 1845. In the minds of the public and of investors, freight transport was secondary. During the first railway share crash in late 1848, there were many calls for management changes, even aside from those for better audit[33]. Many of those calls were for curtailing freight services[34]. Yet by 1852, freight revenue on British railways were higher than those from passengers, and continued

[31] More detailed discussion on this point is in Odlyzko, A. (2016) 'The early British railway system, the Casson counterfactual, and the effectiveness of central planning,' *Essays in Economic & Business History,* vol. 34, 2016, pp. 60–94. Available at ⟨http://www.ebhsoc.org/journal/index.php/journal/article/viewFile/322/302⟩.

[32] Lardner, D. (1841) 'Correspondence between Dr. Lardner and the Editor,' *American Repertory of Arts, Sciences, and Manufactures,* vol. 4, no. 4, November 1841, pp. 246–254.

[33] Odlyzko, A. (2011) 'The collapse of the Railway Mania, the development of capital markets, and the forgotten role of Robert Lucas Nash,' *Accounting History Review,* vol. 21, no. 3, November 2011, pp. 309–345. Extended preprint available at ⟨http://ssrn.com/abstract=1625738⟩.

[34] The most prominent were those of John Whitehead, a member of the London Stock Exchange, and former Secretary of the South Eastern Railway. He launched a pamphlet war with his first piece, *Railway Management: Letter to George Carr Glyn,* which led to rebuttals from Mark Huish and others, and counterarguments from Whitehead.

to grow as a fraction of the total. This came as great surprise to most observers, even those involved in running railways.

Lardner showed good insight in explaining the reasons freight revenues had generally lagged the already low expectations. In modern terms, this was caused primarily by the difficulty of reorienting supply chains to take advantage of a new transport mode. In addition, competitors such as canals lowered their charges. In passenger transport, railway superiority was overwhelming, but that was much less so in the case for goods.

The part of 'Railways at home and abroad' that attracted the greatest attention in contemporary press concerned locality of traffic. Lardner wrote:

> In estimating the manner in which the railways minister to the public service, the question arises–whether they chiefly serve as means of personal intercourse between those great centres of population and commerce which are usually selected as their *termini*; or, whether they in a greater degree benefit the population located in those districts of the country through which they pass. Unquestionably the general impression was, and, so far as we have observed, still is, that the great mass of their traffic is derived from the large cities and towns at their *termini.* This question has much interest, not merely to the public in general, but to those who engage in railway speculations in particular. Is the population of the country through which a line of railway passes, or the population of its *termini,* to be considered most in calculating its probable success?

He then proceeded to display statistics that showed most passengers traveled short distances: the average trip was 15 miles. And after some discussion, he concluded:

> It is clear, then, that the terminal populations have but little connexion with the financial success of railway projects. The main support is short traffic.

He certainly felt that this was a novel observation, one that his readers would find surprising. And they did, as is described in the next section, even though there had already been many other published items that demonstrated this contrarian fact[35]. However, while Lardner did say this was important for railway investors, he did not spell out why. In particular, he did not say that it explained the discrepancy between his 1836 theory that the number of railway passengers was about twice what the traffic takers projected, and the accuracy of traffic taker revenue estimates. Nor did he go into the implications for advisability of the 'direct lines' that were deluding investors[36].

Lardner provided some more explicit warnings about mistakes that railway investors were making. In particular, he argued that actual construction costs were not going to be as low as promised. He noted, with hard data, that on the main lines of the 1830s 'the estimated capital [was] not even a tolerable approximation to the cost,' and after considering various 'items of expenditure' concluded the same was going to happen with the Railway Mania

[35] See a partial list in Odlyzko, A. (2015) 'The forgotten discovery of gravity models and the inefficiency of early railway networks,' *OEconomia,* vol. 5, no. 1, pp. 157–192. Available at ⟨http://oeconomia.revues.org/1684⟩.

[36] See Odlyzko, *op. cit.* (note 31).

projects. And so it turned out to be! Both then, and in most large construction projects before and since, to this day.

Using a more realistic cost for railway construction, Lardner then did some basic arithmetic. He observed that 'a gross revenue of £3000 per mile, on the existing lines, only [paid] an average profit of about [5%].' Therefore the total network that was to be built of 9,000 miles would need to produce annual revenues of £27 million just to produce that same 5% profit, much less the 10% one that investors were dreaming about. The £27 million he clearly regarded as visionary, especially since earlier in the article he had presented data showing railway revenues in Britain in the year to mid-1845 had been only slightly above £6 million. To strengthen the message he noted that while at that time, about 34 million passenger trips were made each year, to produce the £27 million total revenues, there would have to be about 153 million such trips. He concluded:

> This subject opens many curious and interesting views; but our limits warn us that we must at present dismiss it.

It is a great pity that he did not go into those 'curious and interesting views,' and the possible reasons for this decision are discussed in the conclusions. Still, for anyone not intoxicated by the Railway Mania financial elixir, the message should have been clear, the dreams of easy and bountiful profits were illusory. The figure of £27 million per year should have served as a wake-up call for investors. It was about half of the total national budget, and just about what the country was paying each year in interest on its immense national debts stemming largely from the long wars with France that ended in 1815 at Waterloo.

Reception of Lardner's survey

'Railways at home and abroad' did attract intense attention. Some was likely due to its intrinsic merits. Most of the interest in this article, though, was likely stimulated by the forum and timing of its appearance. October 1846 was a critical period for the Railway Mania. The excitement of 1845, with its 'instant effortless riches' atmosphere, culminated in the notorious 30 November 1845 rush to deliver plans to the Board of Trade. Share prices began going down even before that event. But the heavy investments were just starting in the fall of 1846, as even the projects sanctioned by Parliament in 1845 had not yet fully ramped up their spending. Shareholders were beginning to face the prospect of having to find huge sums to build their lines. In the meantime, the general economic outlook was darkening. There were widespread crop failures throughout Europe. Most serious was the almost total destruction of the potato crop in Ireland, which led to the death of about a million people over the next year.

Many observers read Lardner's piece carefully for its potential political implications. Peel's Conservative government fell in June 1846, and the Whigs took over. However, they had only a few weeks in office before Parliament adjourned for the fall. Thus there was much uncertainty and intense curiosity about the new government's railway policy. In the words of the *Scottish Railway Gazette,* the *Edinburgh Review* was 'considered as the organ' of

the Whigs, and 'the leading principles' of the article were 'no doubt, such as the Government [might have been] rightly supposed to entertain'[37]. Some observers applauded those 'leading principles,' but most, especially in the railway press, denounced them. Thus the *Scottish Railway Gazette* called Lardner's work a 'synopsis of the leading fallacies and misrepresentations by which it is sought to impose unfair and impolitic restrictions upon railway property,' and a trial balloon for a program of 'confiscation and usurpation of the most odious kind' written by a 'Morrisonian writer.' This railway paper did mention that Lardner's article covered much more than policy issues, but it dealt just with those.

Many reviews of 'Railways at home and abroad' concentrated on various historical vignettes that Lardner included. Others cited his comparative statistics of railways in various countries. The greatest interest, though, appeared to be aroused by his discussion of locality of traffic. The earliest review that has been located, in the *Morning Chronicle,* contained extensive reprints of passages from Lardner, including the one about 'short traffic' being the dominant source of revenue. About two weeks later, the *Morning Herald* also published a favorable review, and this time we can be certain the editor regarded that passage as very important, as it was again reprinted, and this time it formed a very large fraction of what was reprinted. As yet another example, the *Perthshire Courier* first published some historical excerpts from Lardner's survey, and a week later some further ones[38]. In the latter issue, it prefaced the passage about 'short traffic' with the note

> With regard to the question , whether railways derive their traffic from the great towns usually selected as *termini*, or from the districts through which they pass, the writer says,—

Thus the British press pretty clearly thought that Lardner was pointing out something novel, contrarian, and important. But did they realize what it meant for railway investments? That is not clear. Not one of the articles that have been found that cited Lardner's work said anything about its implications for the advisability of building 'direct lines,' for example. Also, none of them mentioned any of the other publications that had appeared shortly before that emphasized the importance of locality of traffic.

It is worth noting that none of the reviews discussed or reprinted Lardner's assumption of continued incremental growth. It appears to have been too foreign to the contemporary mind, and so was ignored. Further, none of the reviews said anything about the growth in goods traffic. Many of the reviews featured long quotes from the survey, but few had comments about it, and even when they did, those comments tended to be short. Note that the prospects of continuing growth into the indefinite future could have been used to fortify investors' faith in the Railway Mania projects. However, it appears that such prospects were

[37] *Scottish Railway Gazette,* 17 October 1846, pp. 461–462.

[38] *Morning Chronicle,* 12 October 1846, p. 2; *Morning Herald*, 28 October, p. 4; *Perthshire Courier*, 28 October, p. 2 and 5 November, p. 4.

not used in that way by any prominent source until *The Times* used them three year later, in September 1849, and it was then criticized for its 'visionary' projections[39].

There was one detailed and scathing review, aside from several attacks on Lardner's 'Morrisonian' policy passages. It was, as was usual for that period, anonymous. However, it was surely written by Hyde Clarke, a very interesting character. It appeared in the *Railway Herald*, which was owned and edited by Clarke. By 1846 he had worked as a railway engineer as well as a railway journalist, and would later work as a telegraph engineer and a very controversial philologist, and was influential in the development of capital markets as a long-time Secretary of the Council of Foreign Bondholders[40]. Clarke fancied himself as the statistician of railways, with some long and boring publications in that area that lacked any serious novel insights[41]. He may have been envious of Lardner's work, and appears to have harbored substantial personal animosity towards Lardner. By that time, it was generally accepted that Lardner was the author of 'Railways at home and abroad.' In his review[42], Clarke expressed astonishment that a publication as eminent as the *Edinburgh Review* would ever consider entrusting a serious task to such an incompetent observer as Lardner. Clarke listed 9 other people who he claimed were far more qualified, including, hidden modestly in the middle of the list, a 'Mr. Hyde Clarke.' Clarke claimed that Lardner '[had] been forced to his old plan of learning the subject, while he was teaching it, and although quickly learned, it has not been well learned.' Clarke asserted that 'the whole affair is most trumpery and contemptible,' and proceeded to just 'notice two or three of the grosser errors.' There were indeed some obvious mistakes, including some in arithmetic (possibly typographical errors), as well as a statement that the notoriously dangerous American railroads were safe, and a claim that eight million laborers were involved in constructing German railways. Clarke concluded his review with the assertion that '[the] whole is a collection of trash, on which not the least dependance can be placed.' He said little about the most significant of Lardner's observations, and may not have understood them. In particular, in the list of errors, he included the sentence:

> At ... [Lardner] calculates that the nine thousand miles of railway must produce £27,000,000 per annum.

This was clearly marked as an error, but Clarke did not explain what was wrong about it. Yet that was an irrefutable arithmetical deduction, key to the fatal fallacy of the Railway Mania.

In all the coverage of Lardner's survey that has been found in Britain, there was just one sign of recognition that it predicted an investment debacle. The 17 October 1846 issue of the weekly *Bradshaw's Railway Gazette* had a leader entitled 'Trunks, branches, and extensions. Competition and profits.' It showed serious concern that the headlong

[39] Odlyzko, *op. cit.* (note 31).

[40] Some of his later activities are chronicled in Flandreau, A. (2016) *Anthropologists in the Stock Exchange: A Financial History of Victorian Science,* Univ. Chicago Press.

[41] This is not to say that he was incapable of novel insights. He had many, some correct ones. In fact, he is credited with the first statement of a theory of cyclical behavior in the economy, long before Kondratieff.

[42] *Railway Herald*, 31 October 1846, p. 518. Clarke had a brief note about Lardner's piece two weeks earlier, and attempted to refute some of its arguments, in the Morrisonian line, at great length in the issue of 7 November.

expansion of the railway system would damage its profitability. Some examples were cited, but no quantitative arguments were presented. A week later, this paper reprinted several sections from Lardner's survey, on costs, revenues, profits, social savings, and importance of locality. The next issue, that of 31 October, reprinted in a prominent place the 'reticent Cassandra' part of Lardner's article, the one that pointed out just how large a jump in spending on railways would have to be to fulfil investor hopes. However, it did not provide any comments on it. But one of the leaders in that issue was entitled 'Value of railway stock.' It discussed the unrealistic prices of railway shares at the height of the Railway Mania, ones that 'were not justified by any reasonable estimate of profits, present or future.' It pointed out the hurdles the industry faced in its expansion, and did not 'see any reason for supposing that things have arrived at the ultimate point of depression, but, on the contrary, much that points in an opposite direction.' No reference was given to the quote from Lardner's survey, and no quantitative arguments were presented. But clearly the editor of that paper had a pessimistic outlook, and that is likely what induced him to reprint that crucial passage from Lardner.

It is very surprising that so little attention was paid to Lardner's clear implication that Railway Mania projects were destined, in most cases, for financial failure. A year earlier, the *Spectator* had published a piece entitled 'Magnitude of railway speculations' that was explicit in its warnings along the same lines[43]. It was based on projects authorized just through the 1845 Parliamentary session, and which were thus in total less than half those that were afoot by the time Lardner's survey appeared. It computed that to provide moderate profits, railways under construction or approved that year would need to produce £12 million in annual revenues. The author of that piece regarded that figure as chimerical, and claimed that

> the brokers who are agents in the transfer of shares often ask each other in wonderment, where all the travellers are to come from. ... The boldness and extent of these aggregate undertakings conveys a magnificent idea of the resources and enterprise on Britain; but their very magnitude lies like a load on the imagination, while the incessant restlessness and swift movements they presuppose in such a numerous class of the community make the head giddy only to think of.

This was clearly a strong dose of pessimism. But the author of that piece did not note that annual railway revenues were already over £6 million. Thus only a doubling was required to justify financially the rail network planned in late 1845, not the 350% growth required by the network projected a year later. In fact, railway annual revenues reached £12.7 million already in 1850. On the other hand, it was only in the 1860s that they passed the £27 million threshold.

Americans appear to have grasped the investment implications of Lardner's work better than the British. The *American Railroad Journal* reprinted it in full over several issues, starting with the one of 12 December 1846. In an introductory note, the editor noted this was 'an exceedingly well written article' that he 'was sure [readers would] find it

[43] *Spectator*, 16 August 1845, pp. 782–83; reprinted in *The Times*, 18 August, and in numerous other publications, including *Law Times*, 13 September 1845, p. 509.

both interesting and instructive,' and that they would 'be amply repaid by an attentive perusal of it, *long* as it is.' No comments were provided on any of the various parts of the survey, though. A few months later, though, in the 6 March 1847 issue, this paper had an article entitled 'Railroads in England.' It was based on Lardner's survey. This was explicitly acknowledged, but the writer seemed oblivious of the fact that this same paper had already reprinted the entire Lardner work just a few months earlier. Many statistics were reprinted. The writer clearly thought Americans were just as wrong about locality of traffic as the British, as he noted that 80% 'of the passengers not going over twelve miles each. This is contrary to what is generally supposed to be the case, most people thinking that the income from travel is derived from persons going from one end of the line to another.' There was extensive coverage of data about finance of railways, including the estimate of Lardner that the average rate of return on completed lines was 5%, not the widely quoted 10% figure. This elicited from the writer the comment, 'Is not this pretty much what has been the result in the United States?' This article concluded that there would be economic suffering, even in the U.S.,

> in consequence of the delusion on the subject of railroads in England. Even if the several schemes should all be successfully carried out without producing any immediate disastrous results, it is by no means probable that all the new lines will be profitable, and hence large amounts of capital will be sunk, ...

Why would Americans be more perceptive on this topic than the British? Likely because they were not in the grip of an investment mania. Not only that, many of the American railways at that time were struggling financially. In contrast, practically all British railways that were in service were decently profitable, even if not to the extent imagined. This likely made Americans more receptive to sober views.

Strengthening Lardner's warnings

'Railways at home and abroad' provided data and arguments to show that most Railway Mania projects were bound to be business failures. Unbiased observers should have understood that, but, as in most financial manias, there were few able to take cool views of the situation, and Lardner's warnings were largely ignored. It is possible his paper did influence the subsequent course of the Railway Mania to a minor extent. The trough in the rail share market was not reached until the fall of 1849, three years after the publication of 'Railways at home and abroad.' It appears that it was only at the tail end of that period that the public accepted that investments of the Railway Mania were irretrievably lost, and even then tended to blame fraud (especially by George Hudson, the 'Railway King') for the debacle[44]. However, already during those three intervening years, many projects were abandoned or curtailed. It is possible that Lardner did help induce a sense of caution that helped moderate the scale of investments.

Whether deeper and more detailed arguments in 1846 about the inevitable failure of the Railway Mania would have had a different reception is debatable. But it was definitely

[44] Odlyzko, *op. cit.* (note 10).

possible to come up with reasoning even more convincing than that presented by Lardner, using data that was widely available[45]. For example, the £27 million figure computed by Lardner as required to justify the planned investments was not just implausibly large in relation to the size of the national budget. It was also implausible in view of the money being spent on all forms of transport. At a deeper level, one could show that this figure could not have been obtained if the traffic taker methodology was being applied properly. That methodology relied heavily on estimates of coach travel. Passenger coaches were heavily taxed, based on their capacity, and as a result there were good statistics on them. Those statistics can be used to show that to produce anything close to the revenues the traffic takers were projecting, there had to be some double counting, with the same road passengers being counted on by several projects to stimulate multiple rail passengers on each. Yet another deeper investigation, one that looked at the Parliamentary reports on various projects, would have shown that traffic takers in the mid-1840s were not using the exact method from the mid-1830s that had been validated by experience, but a modified one that produced higher estimates. Thus traffic taker revenue estimates during the Railway Mania were bound to be overestimates.

There were also some simpler ways that Lardner could have made his warning to investors stronger. One was to point out that the revenue predictions for the 1830s projects were seldom exceeded. Hence it was very unlikely that the predictions of the 1840s would be exceeded. However, traffic takers in the 1840s were only predicting that profits would be around 6.5% of capital. So even if the engineers did what they have almost never done in history, namely deliver within budget, the most that investors could have expected was a 6.5% dividend, not the 10% they were dreaming and talking about. Once one made allowances for the inevitable cost overruns, Railway Mania investments did not look very inviting even on the surface.

The simple argument above would have been even more convincing had Lardner explicitly coupled his discussion about dominance of local traffic to traffic taker methodology. That would have explained (at the cost of pointing out the fallacy of his 1836 4x theory) how railway enthusiasts were table to talk of 'demand that exceeded expectations,' while revenue estimates were about on target.

Lardner could also have provided some explicit recent examples to support his arguments. For example, he was absolutely correct in his skepticism about the lower construction costs that were promised for new railways. He substantiated that skepticism with statistics of cost overruns for some major lines of the 1830s. That argument could have been reinforced by citing a recent example (one of the very few available, as hardly any new projects were undertaken in the early 1840s). The Yarmouth and Norwich Railway was sanctioned by Parliament in 1842, and went into regular commercial service in May 1844. Its costs were far lower than those of the mainlines of the 1830s, due to less expensive materials and labor in an economic depression, and construction through easy terrain. Still, the initial plans, as presented to Parliament and investors, called for total capital investments of £150,000, to be covered in full by shares. In addition, the Act authorized additional borrowing of

[45] A preliminary version is available in Odlyzko, *op. cit.* (note 5). A more detailed version is in preparation.

£50,000 'just in case' (which in practice meant always). In the end, construction and equipment costs (which, in a common practice, were not in the basic estimate, although this was seldom mentioned explicitly to investors) came to almost £240,000[46].

The Yarmouth and Norwich Railway case could also have been analyzed more deeply to show how traffic takers could go wrong. Revenue estimates for that line were made not by a professional traffic taker, but by George Parker Bidder, the famous engineer who was a partner of Robert Stephenson. Unfortunately he assumed that many passengers going by steamboat between Yarmouth and Norwich would switch to the railway, in accordance with the Lardner thesis from the 1836 British Association meeting that speed is what mattered the most. But that turned out not to be the case, low cost and very comfortable travel by water turned out to be preferable for many to the speedier rail.

Some Lardner puzzles

There are several puzzling aspects to Lardner's 1846 survey. In particular, why was he not more explicit in his warnings to investors? At the start of his discussion about importance of short trips, he noted this was a topic of 'much interest, not merely to the public in general, but to those who engage in railway speculations in general.' So he may have been aware of some of the arguments in the preceding section. But he did not present them. Later, he was more explicit in his warnings about the implausible revenue estimates for the planned network, but even there he concluded just with the statement that '[t]his subject opens many curious and interesting views; but our limits warn us that we must at present dismiss it.' It is hard to take the claim about space limits seriously, given the length of the article and the variety of topics whose coverage could have been shortened. It appears that Lardner was being a 'reticent Cassandra,' reluctant to be explicit in his warnings about ruin. It could be that this reticence was imposed by Napier, the editor of the *Edinburgh Review*. The letters of Lardner to Napier show that Napier did shorten the article substantially. Lardner declared himself happy with Napier's cuts, but of course he may have been trying to keep on that editor's good side, as he was angling for a commission for another article. But even if the reticence was Napier's, what could have led to it?

Whether the reticence was due to Lardner or to Napier, there is a somewhat plausible reason for it. The *Edinburgh Review* was 'considered as the organ' of the Whigs, and both Lardner and Napier were likely mindful that the British ruling elite (both Whigs and Tories) were concerned about the potential disruption that the Railway Mania might wreak on the economy. But that elite were even more scared by the prospect of British investors sending their money overseas. So the ruling classes did not want to frighten investors away from

[46] General information about this project is presented in Barney, J. (2007) *The Norfolk Railway: Railway Mania in East Anglia, 1834-1862,* Mintaka Books. This book notes (p. 97) that 'had the full cost been realised at the start it is probable that few railways would have been built at all.' Final capital investment figures are taken from the report of the annual meeting of this line in *Railway Times,* 15 February 1845, pp. 201–202.

domestic projects. It could be that either Lardner or Napier felt that being too explicit about dangers of railway investments might lead to damage to the country as a whole.

Another puzzle is that although the 1846 survey is in many ways a precursor of Lardner's 1850 *Railway Economy,* the latter work does not mention the former. One would have thought that Lardner, who was rather vain, refused to admit mistakes, and resented criticism, would have boasted of having predicted the financial disaster of the Railway Mania. But he did not! That is hard to explain, unless he felt that the British public would resent reminders of their foolishness. As Samuel Butler had written two centuries before Lardner, 'Doubtless the pleasure is as great, Of being cheated, as to cheat.'[47]. There has been a general reluctance over the ages to seriously investigate the causes of investment disasters.

Conclusions

Lardner deserves recognition for his novel contributions in the survey 'Railways at home and abroad.' It was a major achievement in presenting a comprehensive view of railway technology and of the railway industry around the world. Not only that, but it went further, and clearly pointed out the incorrect assumptions on which investors' hopes for profitable returns from Railway Mania projects were based. Had his warnings been heeded, the financial disaster of that episode of investor exuberance could have been avoided. Instead, we find in this story another illustration of how relevant information is often slow to diffuse, especially when it conflicts with accepted dogma and the hopes for instant riches that bubbles inspire. It thus 'opens many curious and interesting views; but our limits warn us that we must at present dismiss it.'

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⟨http://www.dtc.umn.edu/∼odlyzko/doc/mania-ack.html⟩

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[47] Butler, S. (1662–1678) *Hudibras,* Part II, Canto III.